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## ELECTRO-MECHANICAL DRIVE DEVICE

20 Description

The invention relates to a method for manufacturing an electro-mechanical drive device for adjustment devices in a motor vehicle, more particularly for a window lifter.

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In order to raise and lower window panes in motor vehicles electro-motorized window lifters are known which are suitable for installing in the doors of motor vehicles and which have a drive device in the form of for example an electric motor with attached gearing or gear motor which can be connected to a vehicle battery through a wiring connection and switch.

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The window pane which can be raised or lowered in the vehicle door through the electro-motorized window lifter is thereby fixed along its lower edge to a guide slide

which can be moved up and down along a profiled rail by means of for example a closed cable loop. The cable loop runs round a cable drum which is driven for example through a worm gearing of the electric motor in a compact drive device which can have a cable drum in addition to the electric motor and worm gearing and which is  
5 fixed on the supporting parts of the inside of the vehicle door, for example a support plate, in the same way as the profiled rail.

As an alternative to this the drive device can be used to operate a cross-arm window lifter or other adjustment devices in the motor vehicle, for example a horizontal seat  
10 adjuster.

Since different forces are required to raise and lower the window pane the electric motor is connected to a control device, a control and regulating circuit which is connected to a sensor of a measuring system for determining the speed or position of  
15 the electric motor. The control device for raising or lowering the window pane is controlled by the vehicle driver or passenger who operates the control switch.

From DE 198 51 455 A1 an electronics module is known for a drive unit which is operated by an electric motor. The electronic components are soldered onto a small  
20 plate in an electronics housing part. To control the drive unit a relay is used to switch on the current supply to the motor.

In EP 0 474 904 an electronics module as previously described is integrated in a gear housing. Also here a relay is switched on to control the current supply to the electric  
25 motor.

For future window lifter systems the torque or rotational speed of the electro-mechanical drive device is regulated through a control device. Regulation of this kind is known from DE 198 23 376 A1 where the semi-conductor circuit is provided with a  
30 semi-conductor bridging circuit. A semi-conductor bridging circuit generally uses four power semi-conductors to switch the current so that the motor can be controlled for both directions of rotation.

If the power semi-conductors are arranged in a thermally poor conducting environment  
35 then the power semi-conductors have to be safeguarded against thermal overload. If

- the temperature in the power semi-conductor is too high then for example a surge breakthrough can lead to destruction of the structural element. In order to keep heating of the power semi-conductor as low as possible the switch-on resistance must be restricted for example through the parallel circuit connection of several transistors.
- 5 For small switch-on resistances however correspondingly large transistor matrices are required, with the correspondingly large amounts of silicon which are necessary.

- The object of the invention is therefore to provide an electro-mechanical drive device which enables the power semi-conductor to be mounted in the gear housing without
- 10 restricting the switch-on resistance of the power semi-conductor. This is achieved through the electro-mechanical drive device having the features of patent claim 1, the method for manufacturing the electro-mechanical drive device having the features of patent claim 16 or the use of a gear housing having the features of patent claim 20. Advantageous further developments of the invention are contained in the sub-claims.

- 15 According to this, the electro-mechanical drive device has a gearing with a gear housing preferably of plastics, an electric motor mechanically connected to the gearing, a control device mounted in the gear housing and having at least one power semi-conductor for controlling the electric motor, and means thermally coupled to the
- 20 power semi-conductor as a heat sink for diverting away waste heat from the power semi-conductor. The means which as heat sink divert the waste heat of the power semi-conductor away from said power semi-conductor are integrated in the gear housing.

- 25 Thus power semi-conductors with a larger switch-on resistance can be used since the waste heat arising at the switch-on resistance can be diverted away through the means acting as heat sink and a build-up of heat which close to the power semi-conductor could lead to the destruction of the semi-conductor structure is avoided. By integrating the means for diverting away the waste heat into the gear housing it is
- 30 possible for the means to undertake further mechanical or thermal functions extending beyond their function as heat sink.

As power semi-conductor is used for example an HVMOS-transistor (high-voltage-metal-oxide-semiconductor). By power semi-conductors are also meant however all

other types of power semi-conductors, such as for example bi-polar transistors or thyristors.

In an advantageous design of the invention the means and a housing of the power semi-conductor are fixed in force-locking connection to couple with one another. Through the force-locking connection contact is ensured between the power semi-conductor housing and the means so that a heat transfer resistance between the housing and the means is reduced for improved coupling. For the force-locking connection fastening elements are used such as for example screw or rivet connections, or more advantageously the means are spring-tensioned through a spring element, for example a leaf spring integrated in the gear housing.

For thermal coupling in a further design of the invention a heat conducting means is mounted between the means and a housing of the power semi-conductor. The heat conducting means is for example a heat conductor paste or a compressible solid body in order to compensate for unevenness and tolerances in the surface of the means or the housing.

In a further embodiment of the invention the gear housing has an opening for inserting the means and guide elements for positioning the means in an end position. The means are fixed in this end position through a fastening element, such as for example a detent catch. A detent catch can advantageously be integrated in the gear housing so that no additional separate fastening elements are required. In the end position the means contact, and are thus thermally coupled with, the power semi-conductor housing which is already in position. As an alternative the means are positioned in the end position and the contact is produced through positioning the power semi-conductor housing. The position of the means and the power semi-conductor housing relative to each other is determined through guide elements which can for example be formed integral with the gear housing.

An alternative further development proposes that the means are injection moulded, at least in part, in the gear housing whereby the gear housing is injection moulded as a plastics housing. Advantageously the control device with the injection moulded parts is additionally injection moulded with the means and previously the power semi-conductor is thermally coupled to the means for example by means of soldering. Parts

of the means are not injection moulded for example in order to improve the dissipation of heat from the injection moulded plastics gear housing.

As an alternative to the further embodiment of the invention already mentioned the means are hermetically sealed in the gear housing against fluids and dust particles in order to prevent the inside of the housing from becoming soiled, without providing additional sealing for the means. To this end it is necessary to position the means on a wall of the gear housing, with the wall having thinner walls than the supporting parts of the gear housing in order to offer a lesser heat transfer resistance compared to the supporting parts of the gear housing. To this end the wall has a thickness of less than one millimetre for example.

In an advantageous further development of the invention the means have a further thermal coupling with a cooling element, for example the sheet metal plate of a door module or a metal frame of a vehicle seat on which the gear housing of the drive device is fixed. The means are in this case a heat conductor which is fixed on the cooling element, for example a support plate, and diverts the heat which is to be drawn off through a further thermal coupling to the cooling element. The heat conductor is advantageously made from aluminium, copper or another material having good heat conductive properties.

An advantageous design of the further development of the invention already mentioned has a mechanical connection between the means and the gear housing, and a fastening element is integrated in the means for fastening the gear housing on the support plate. A fastening element is for example an opening as a screw-in point or a stepped bolt with screw thread. The mechanical connection advantageously increases the stability of the gear housing.

In a further advantageous development of the invention a bearing for a gear element of the gearing is integrated in the means. The bearing is for example a bearing point shaped out of the means and on which a bearing bush slides, the bearing bush arranged for example on the shaft of the worm of a worm gear. In addition the means can be fastened for example by material connection in the gear housing in order to take up the forces acting on the bearing. The means can be for example metal or metal alloy on which the bearing bush slides. Furthermore the integration of the other

types of bearings, such as hole bearings, support bearings or fixed bearings is also possible.

In one design of a further development of the invention the means have positioning elements for positioning the control device relative to the gear element or to a magnet fixed on the gear element. Stamped or bent surfaces or edges of the means are suitable for example as positioning elements. In order to ensure accurate positioning of the positioning elements relative to the gear elements the positioning elements are made, for example, stamped, with the bearing in the same work step.

A further development of the invention advantageously proposes that an opening of the gear housing is closed by the means. In this further development the means are a good heat conductive metal cooling lid which advantageously has cooling ribs for improved discharge of the heat to the surrounding air. The opening is sealed through a material connection between the cooling lid and the edge of the opening, the material connection preferably being provided by an adhesive to stick the cooling lid to the edge of the opening.

In a further advantageous development of the invention conductor panels which are insulated from each other are placed on the means to connect structural elements, for example the power semi-conductor, and interfaces of the control device. The interfaces of the control device are for example the interface with the electric motor contacts, with the functional units of the motor vehicle or with a sensor. The conductor panels are made for example through structuring a metal.

As a further possibility of integrating the means into the gear housing the means can be formed as part of a plug of a connector element of a wiring connection on the side of the drive device. The means can for this purpose be for example a metal plug-in collar which can be used at the same time as a screen guard for the signal leads.

For a process for manufacturing an electro-mechanical drive device for adjustment devices in a motor vehicle, more particularly a window lifter, a gear is used in a gear housing and an electric motor is mechanically connected to the gearing. A control device controlling the electric motor and having a power semi-conductor is mounted in the gear housing and a means acting as heat sink is integrated in the gear housing. At

the same time as fitting the means as heat sink in the gear housing or as fitting the control device in the gear housing the power semi-conductor is thermally coupled to the means acting as heat sink through a contact between the heat sink means and the power semi-conductor.

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The invention will now be explained in further detail with reference to the embodiments shown in the drawings in which:

- Figure 1 shows an electro-mechanical drive device with cooling lid;
- Figure 1' shows a diagrammatic sectional view of the drive device;
- Figures 2a and 2b show diagrammatic side views of an embodiment of the means as mechanically bi-stable element;
- Figure 3 shows an electro-mechanical drive device with a heat conductor;
- Figures 3a and 3b show detailed views of the electro-mechanical drive device with heat conductor
- Figure 4 shows an electro-mechanical drive device with injected heat conductor;
- Figures 4' and 4'' show views of different embodiments of the heat transfer of the heat conductor , and
- Figure 5 shows the double function of the heat conductor as bearing of the worm shaft.

Figure 1 shows an embodiment of an electro-mechanical drive device of a window lifter. An electric motor A1, here for example a commutator motor A1, is connected

mechanically to a gearing. The housing of the electric motor A1 is fixed to the gear housing A2 through a screw connection A12 between the electric motor A1 and the gear housing A2. The gear housing A2 is in this embodiment an injection moulded plastics housing, but alternatively a metal housing could be possible. The gear housing A2 has several screw points A20 through whose opening the gear housing A2 is screwed onto a support plate (not shown in Figure 1).

An output pinion A29 is guided through an opening (not shown in Figure 1A) in the support plate on which is fixed a cable drum (likewise not shown in Figure 1A) over which the cable of a window lifter is driven. A gearing, not shown in Figures 1 and 1A is mounted inside the gear housing A2. The gearing consists for example of a worm which is connected to the axle of the electric motor A1 and which drives a worm wheel connected to the output pinion A29.

For controlling the electric motor A1 a control device A5 is integrated in the gear housing A2. The control device A5 is connected electrically or optically through a connector element of a wiring connection on the side of the drive device to further functional units (not shown) of the motor vehicle, for example to a door control device or to a battery. The connector element on the side of the drive device has a plug-in collar A3 and contact elements A4. The plug-in collar A3 is formed integral with the injection moulded gear housing.

The control device A5 is positioned through a side opening A25 of the gear housing A2. When the control device A5 is in position the motor contacts A51 are in contact with the electric motor A1. In order to draw off the waste heat of the power semiconductor, an HVMOS transistor, which is integrated in the control device A5, the said control device A5 is thermally coupled to a means A9 acting as heat sink. The means A9 is in this case a cooling lid A9 which has numerous cooling ribs. The cooling ribs enable a rapid discharge of the waste heat taken up by the cooling lid, to the surrounding air. The cooling lid A9 is welded by ultrasound welding into the opening A25 of the gear housing A2 until good thermal coupling is ensured through contact between the cooling lid A9 and the control device A5.



Figure 1' shows diagrammatically a sectional view of a drive device. The control device A5' is mounted in the gear housing A2' with the motor contacts A51' and the contact pins A4' of the connector element on the drive device side through the formation of the gear housing A2', the plug-in collar A3' and the motor connections A15' so that the cooling lid A9' during insertion in the gear housing A2' makes a good thermal contact with the control device A5' and the cooling lid A9' has only to be fixed to the gear housing A2' through an adhesive material connection. The adhesive forms in a double function the sealing element to seal the inside of the gear housing A2'.

- 10 Figures 2a and Figure 2b show the means B9 formed as a mechanically bi-stable cooling lid B9. In a first step the control device B5 is positioned, with the contact pins and the motor contacts B51 as well as a sealing rubber B6 for sealing the plug-in collar B3, in the plug-in collar B3 and the gear housing B2. In a second step the mechanically bi-stable cooling lid B9 is fixed in the gear housing B2. In the third step
- 15 the mechanically bi-stable cooling lid B9 is moved from a first mechanically stable state into a second mechanically stable state in order to thermally couple the means B9 through a contact in the second mechanically stable state to the housing (B5) of the power semi-conductor.
- 20 Figure 3 shows an electro-mechanical drive device with a heat conductor C9. The heat conductor C9 is in this case formed as a cooling angle. The drive device in Figure 3 is fixed on a support plate analogous with the drive device of Figure 1. The support plate is often of a metal to ensure the mechanical stability of the window lifter. The object of the heat conductor C9 is consequently to divert the waste heat from the
- 25 power semi-conductor to the metal support plate.

To this end the heat conductor C2 has two thermal couplings, on the one hand to the power semi-conductor integrated in the control device C5, and on the other to the support plate. Figure 3 shows an insert solution for integrating the heat conductor C9 in the gear housing C2. The heat conductor C9 is already thermally coupled to the control device C5 prior to insertion, with the heat conductor C9 being connected to the control device C5 through material connection, for example soldering. In addition a suppressor element C53, here for example an electrolyte capacitor C53, is attached, for example soldered on to the control device C5.

At the point where the thermal coupling between the heat conductor C9 and the support plate requires the smallest possible thermal resistance, the wall C92 of the gear housing C2 is made correspondingly thin, less than one millimetre.

5 Figures 3a and 3b show detailed views of the electro-mechanical drive device. The control device C5 has the motor contacts C51 for contacting the electric motor C1 and the contact pins C4 for a plug. An electrolyte capacitor C53 is soldered by its two connectors C534 to the contact pins C4. In order to thermally couple the power semi-conductor which is integrated in the control device C5 to the cooling angle C9 which is  
10 formed as a heat conductor C9, the cooling angle C9 is connected with material engagement to the housing of the control device C5. This unit comprising control device C5, suppressor element C53 and cooling angle C9 is inserted in the opening C25 of the gear housing C2 and then a plug-in collar C3 is fitted on and the unit is cast in the gear housing C2 through a casting mass.

15 For additional fixing, a screw opening is integrated as fastening element in the cooling angle C9. The drive device is screwed through the screw opening to the support plate through a screw. The metal of the cooling angle C9 thereby additionally stabilises the gear housing C2. All other types of fastening elements, for example threaded bolts,  
20 can also be integrated as fastening element C90.

Figure 4 shows an electromechanical drive device which is very similar to the drive device of Figure 3. In the case of Figure 4 the gear housing D2 is formed in one piece of plastics without an insert for the control electronics with the plug-in collar D3. Figure  
25 4' and Figure 4" show two possibilities of the thermal coupling between the cooling angle D9', D9" and the support plate. In Figure 4' the cooling angle D9' is injected with the control device D5' in the gear housing D2'. The electrolyte capacitor D53' is subsequently fitted into the housing D253' and the connections D534' of the electrolyte capacitor D53' are soldered to the contact pins D4'. The electrolyte capacitor D53' is  
30 alternatively contacted with the plug contacts. The cooling angle D9' is injected into a thin wall D92' of the gear housing.

In Figure 4" the cooling angle D9" however on the side of the support plate is not injection moulded with the plastics of the gear housing D2". The side facing the

housing D253" of the electrolyte capacitor (see Figure 4' as D53') is supported by the plastics of the gear housing D2" in order to increase the mechanical stability of the screw-in point D90" integrated in the cooling angle D9". In Figure 4" only the cooling angle D9" is injection moulded whilst the control device D5" is pushed into the opening D25" of the gear housing D2" and is positioned by the cooling angle D9" as guide element D9".

Figure 5 shows the integration of a bearing E9115 in a cooling angle E9. The shaft E115 of a worm (not shown in Figure 5) is mounted with sliding action in the bearing E9115, in this case a bearing hole E9115. In order to ensure a fixed position in the gear housing (D2", analogous with Figure 4") the cooling angle E9 is injection moulded at least in part in the gear housing (D2"). The alloy of the cooling angle E9 is matched with the alloy of the shaft E115 in order to optimise the sliding properties.

A Hall magnet E155 is mounted on the shaft E115 positioned relative to a surface of the cooling angle E9. The control device E5 is inserted and positioned between the Hall magnet E155 and the surface of the cooling angle E9 so that thermal coupling is achieved through good contact with the surface of the cooling angle E9 and accurate positioning relative to the Hall magnet E155. The interaction of the Hall sensors integrated in the control device E5 in respect of the Hall magnet is optimized by the accurate positioning. In order that the control device E5 is in the optimum position accordingly, surfaces are provided in the cooling angle E9 acting as guide elements for guiding the control device E5 which is to be inserted.

## LIST OF REFERENCE NUMERALS

	A1, C1, D1, D1"	Electric motor
	A3,A3', B3, C3,D3,D3", E3	Plug-in collars
5	A4,A4',B4,C4,D4',D4",E4	Contact elements
	A20, C20, D20, D20"	Screw-in opening, screw-in point
	A2,A2',B2,C2,D2,D2',D2"	Gear housing
	A29, C29, D29"	Output pinion, output element
	C53, D53'	Suppressor element, electrolyte capacitor
10	C253, D253, D253', D253"	Housing of electrolyte capacitor
	C534, D534'	Connector elements of electrolyte capacitor
	A12, C12, D12	Motor screw connection
	A51, A51', B51', C51, D51",E51	Motor contacts
	A5, A5', B5,C5,D5',D5",E5	Control device
15	C32, E32, D32"	Casting opening
	A15', B15	Motor connections
	E115	Worm shaft
	E115	Hall magnet
	A6', B6	Rubber seal
20	A9, A9'	Cooling lid
	C9, D9, D9', D9", E9	Heat conductor element, cooling angle
	B9	Mechanically bi-stable means as heat sink
	C90, D90,D90',D90",E90	Fastening element, screw-in opening of heat conductor element
25	C25,D25"	Insert opening
	A25	Side opening of gear housing
	C92, D92, D92'	Thin wall of gear housing
	E9115	Bearing integrated in means for bearing the worm shaft